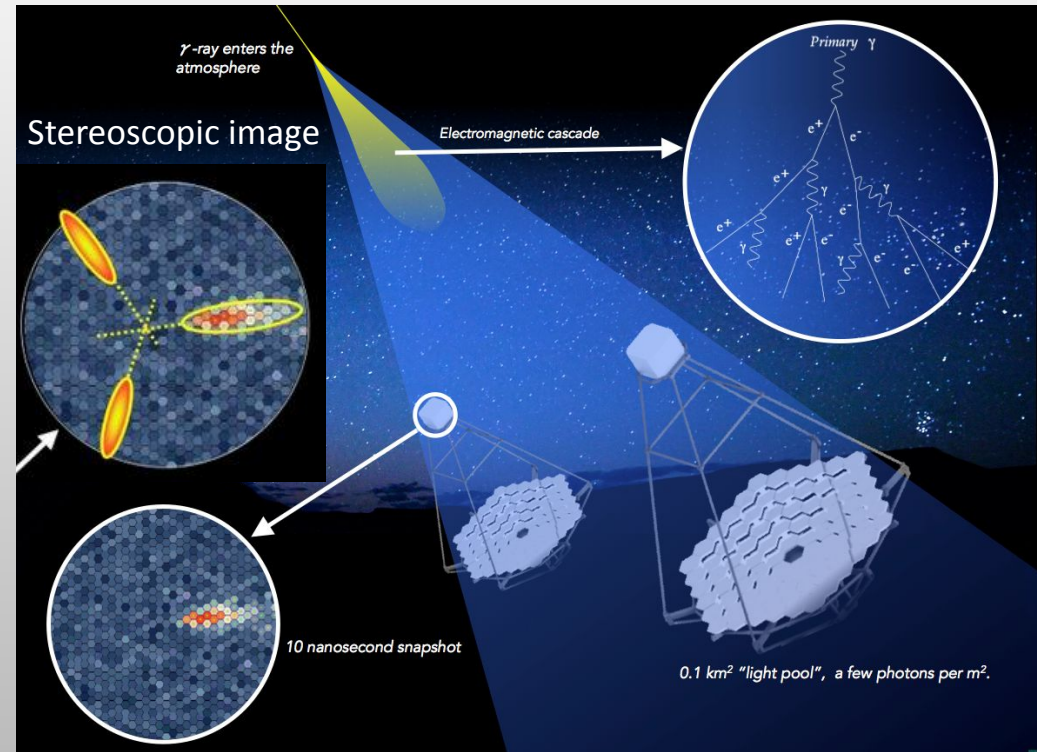# Accelerating Machine Learning algorithms in FPGAs for the trigger system of a SiPM-based upgraded camera of the CTA Large-Sized Telescopes

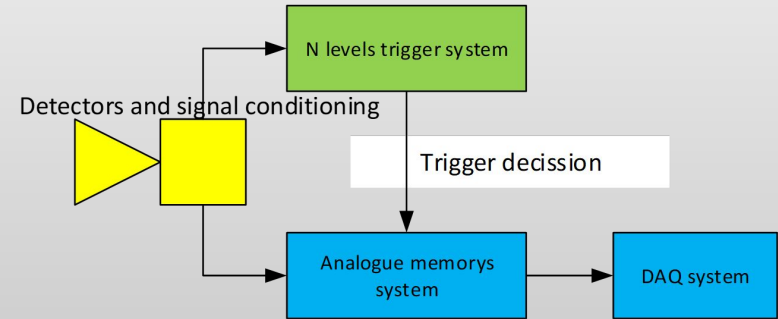A. Pérez Aguilera[1], L. Á. Tejedor[1], J. A. Barrio[1], T. Miener[2], D. Martín[1]

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(2) University of Geneva - Département de physique nucléaire et corpusculaire, 24 Quai Ernest Ansernet, 1211 Genève 4, Switzerland
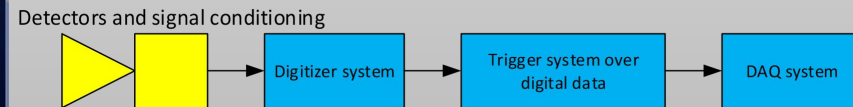
IACTs introduction

Stereoscopic image

γ-ray enters the atmosphere

Electromagnetic cascade

Primary γ

10 nanosecond snapshot

0.1 km² "light pool", a few photons per m².

Combined analogue and digital trigger system approach with a separated branch for event data:

Detectors and signal conditioning

N levels trigger system

Trigger decission

Analogue memorys system

DAQ system

Fully digital trigger system approach:

Detectors and signal conditioning

Digitizer system

Trigger system over digital data

DAQ system
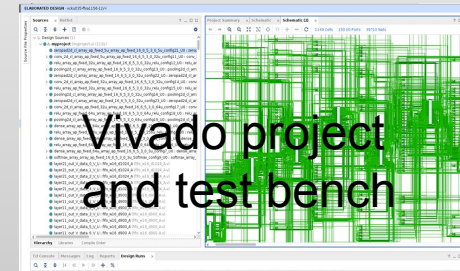
Implementing ML algorithms for the trigger system

Fully digital trigger ⇒ More complex algorithms to tag/eliminate NSB events ⇒ Possibility of Machine Learning

Hundreds of kHz ⇒ Processing time few μs ⇒ FPGAs

Reduced TensorFlow model used for IACT offline event analysis.

Preliminary results when simulating with RoIs composed of 5 samples of 30x30 pixels

R. Factor	Latency (us)	DSP
1	5.2	122
8	12.9	66
16	15.3	52
32	15	29
64	20.4	17
128	33	9
256	41	6

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Discussion and near future activities

-**Several RoIs** need to be processed **in parallel** to cover all the area of a camera event.

-Further optimizations of the CNN models, such as **quantization aware training**, are yet to be explored.

-Density-Based Scan models also to be explored.

-Works to check the **tagging performance** are ongoing.

-Recently joined DRD7.5 WP to share expertise.

-Short-term: test-bench/algorithms characterized by 2026.

Mid-term: full prototype produced by 2028.

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